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BOORALANA TRICARINATA, A NEW SPECIES OF ISOPOD FROM THE WESTERN ATLANTIC OCEAN (CRUSTACEA: ISOPODA: CIROLANIDAE)

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Abstract.—*Booralana tricarinata* is described from deep-shelf and upper-slope waters off the Bahamas and the Antilles. It is the third species to be assigned to the recently erected cirolanid genus *Booralana* Bruce, 1986, and the first record of the genus beyond Australian waters. The large species, reaching 54 mm in length, can be distinguished from the other two species by the presence of a median and a pair of submedian carinae on the dorsal surface of the pleotelson.

Bruce (1985:714) discussed 15 genera in a synopsis of the Cirolanidae of the Caribbean Sea and Gulf of Mexico and presented a key to the 12 nontroglobitic genera known from that area. Kensley (1987) added a new genus, *Xylolana,* to the Caribbean cirolanid genera. The new species described below represents another cirolanid genus now known to occur in that region: *Booralana* Bruce, 1986. The genus previously comprised only two other species, *B. bathynella* (Bruce, 1981) and *B. wundurra* Bruce, 1986, from the Indo-West Pacific Region at Australia (Bruce 1986).

All measurements are in millimeters (mm). Specimens are deposited in the National Museum of Natural History (USNM), Smithsonian Institution, Washington, D.C.; the Florida Department of Natural Resources Marine Invertebrate Collection (FSBC I), St. Petersburg; the Gulf Coast Research Laboratory Invertebrate Collection (GCRL-I), Ocean Springs, Mississippi; and personal collections.

Cirolanidae
Genus *Booralana* Bruce, 1986
Booralana tricarinata, new species
Figs. 1–5

Holotype.—1 male, 53 mm; Atlantic Ocean, Northwest Providence Channel, about 3 km southeast of Lucaya, Grand Bahama Island, 200–250 m, baited mollusk trap; coll. J. Worsfold, Mar 1984; USNM 229974.

Paratypes.—1 non-incubatory female, 47 mm; Atlantic Ocean, Straits of Florida, west of Little Bahama Bank, 27°04.0′N, 79°18.8′W, ALVIN dive 77-761, no. F-1, 610 m, from fish trap; May–Jun 1977; USNM 229969.—1 male, 51 mm, 66 juveniles, 10–26 mm, 8 fragments; Atlantic Ocean, Northwest Providence Channel, off Lucaya, Grand Bahama Island, 180–220 m, from baited mollusk trap; coll. W. Lyons, J. Worsfold, and R. Quigley, 24 May 1981; FSBC I 32700.—6 males, 34–47 mm, 1 incubatory female, 49 mm, 1 non-incubatory female, 35 mm, 8 subadults 21–29 mm; same data as for holotype; USNM 229975 (2 males, 1 female), FSBC I 32701 (4 males, 1 female, 8 subadults).—4 males, 37–47 mm, 2 incubatory females, 47 and 48 mm, 8 non-incubatory and subadult females, 30–54 mm; Atlantic Ocean, off north coast of Puerto Rico, 18°30′N, 65°42′W, 435 m, R/V *Oregon II* Station 31794, from baited fish trap; coll. S. Candileri, 10 Jul 1980; FSBC I 32347 (2 females), GCRL-I-87-1129 (3 males, 5 females), collection of N. Bruce (1 female), collection of R. Heard (1 male, 2 females).—1 male, fragment; Caribbean Sea,

due east of Vieques Island, Puerto Rico, 110 m, from stomach of *Lutjanus vivanus* (male, fork length 44 cm); coll. E. Rainey, 21 Apr 1971; USNM 229967.—2 adult (?) males (damaged), about 35 and 45 mm, plus several fragments and mancas; Caribbean Sea, Anegada, British Virgin Islands, 65–95 fathoms (118–173 m), from combined stomachs of 5 *Lutjanus buccanella* (fork lengths 26–33 cm); 1 Jun 1971; USNM 229968.—1 female, 31 mm; Caribbean Sea, Redonda Island, West Indies, Smithsonian-Bredin Station 74-A-58, night-light at anchorage (dip net); 17 Apr 1958; USNM 229965.—1 female, 42 mm; Caribbean Sea, west of Portsmouth, Dominica, 274 m, Station 72-59; Finlay mollusk trap; 19 Apr 1959; USNM 229966.

Diagnosis.—Dorsal surface of pleotelson with median carina and one pair of submedian carinae.

Description of holotype male.—Cephalon slightly more than twice as wide as long, rounded anteriorly, lacking rostrum (Fig. 1); medial part of posterior margin concave in dorsal view, only slightly embedded in pereonite 1. Eyes ventrolateral (Fig. 1C), almost completely obscured by cephalon in dorsal view, elongate, more than 3 times longer than deep, extending to posterolateral corners of cephalon; each eye approximately ⅓ length of anterior margin of cephalon. Anterior margin of cephalon with 4 narrow, sinuous carinae; dorsalmost carina extending uninterrupted around margin of cephalon just above eyes; second carina similar and parallel to first one, running along dorsal margin in contact laterally with dorsal margins of eyes; third carina confined to interocular region; fourth carina in contact laterally with ventral margins of eyes, curving dorsally around antennae, extending posteriorly only to midpoint of eyes. Two short, curved grooves on dorsal posterior surface of cephalon lateral to medial concavity of margin.

Pereonite 1 medial length about 1.3 times length of cephalon; lengths of remaining pereonites subequal, less than that of first. Anteroventral margin of pereonite 1 subacute, produced anteriorly beyond posterolateral margin of eye; lateral margin with marginal carina. Pereonites 2 and 3 coxal plates subrectangular. Pereonites 4–7 coxal plates well developed, produced posteriorly into strong, acute lobes. Pereonite 7 posterior margin usually with single row of small tubercles or granules.

Pleonites all free, all visible dorsally. Pleonite 1 partially covered by pereonite 7. Pleonite 3 ventrolateral margin strongly produced, with deep posterior notch; posterolateral margin above notch produced posteriorly beyond those of pleonites 4 and 5. Pleonites 2–5 posterior margins each with single row of small tubercles.

Pleotelson subtrapezoidal, wider than long, widest anteriorly; anterolateral margin concave at junction with uropod; lateral margins slightly raised, convex, converging toward truncate posterior margin; posterior margin straight or sinuous, sometimes appearing bilobed, armed with numerous blunt denticles. Dorsal surface with 3 carinae; one pair of long submedian carinae extending entire length of pleotelson, posteriorly narrow, widening anteriorly and becoming less distinct; one median carina originating at anterior fourth of pleotelson, extending to posterior margin. Pair of pores present anteriorly on dorsal surface of pleotelson lateral to anterior ends of submedian carinae.

Antenna 1 extending posteriorly slightly beyond lateral margin of cephalon. Peduncle not reaching beyond distal half of peduncle segment 4 of antenna 2; bases set slightly apart; segments 1 and 2 subequal in length; segment 3 approximately equal to combined lengths of segments 1 and 2. Flagellum with 23–28 articles. Antenna 2 extending posteriorly as far as pereonite 5. Peduncle segments 1–3 with combined lengths less than that of segment 4; length of segment 5 subequal to that of segment 4; flagellum with 53–58 articles.

Frontal lamina subtriangular, with 2 parts; anterior half subpentagonal, widest posteriorly, with median carina and raised lateral

margins; posterior half subcircular, produced anteriorly, highly punctate, with well-rounded posterior margin. Clypeus slightly concave posteromedially, forming 2 pronounced anterior lobes enclosing posterior basis of frontal lamina.

Mandibles asymmetrical; left incisor overlapping right (Fig. 2). Posterior cusp of incisor process of left mandible enlarged, with posterior margin folded ventrally, forming receptacle for posterior cusp of incisor process of right mandible. Lacinia mobilis present on both mandibles, left bearing about 18 slightly curved, corneous marginal spines, right bearing about 15 spines; spines irregular in size and shape. Palp with 3 segments; segment 2 approximately twice length of segment 1, length approximately 2.5 times greatest width; inner face of distal half with dense cluster of simple setae; distal segment weakly falcate, with concave margin bearing dense row of simple setae, distalmost seta longest.

Maxilla 1 exopod with 12 dark, corneous spines; distal portion of exopod broadened, with 3 lateral spines, distalmost strongly developed, robust; row of lateral spines curving to join row of 8 medial spines; single smaller spine present between medial and lateral rows. Endopod hatchet-shaped; outer distal angle almost square; inner margin with 3 plumose spines.

Maxilla 2 and maxilliped as illustrated, typical for family. Maxilliped endite with 2 coupling hooks.

Pereopods 1–3 anteriorly directed, subequal in length; pereopods 4–7 posteriorly directed, increasing in length posteriorly.

Pereopod 1 stouter than remainder (Fig. 3); dactylus with dark, corneous unguis; propodus flexor margin with 5–6 blunt tubercles, distal margin of each tubercle armed with secondary, short, corneous spine; carpus short, inserted into merus; merus deeply notched laterally, with well developed, anteriorly directed pad on flexor margin extending almost to distal margin of carpus, pad armed with 6–7 short, corneous spines laterally and 4–5 blunt tubercles medially, tubercles similar to those on propodus, dorsal extensor margin lacking spines; ischium dorsal extensor margin with 2–3 setae, lacking spines.

Pereopods 2–3 similar; dactylus and propodus similar to those of pereopod 1 but more slender; carpus inserted into shallow notch of merus, distal flexor margin armed with 3–5 short, corneous spines; merus with pad on flexor margin not extending to distal margin of carpus, pad armed with 9–12 short, corneous spines laterally, lacking medial tubercles, dorsal flexor margin armed distolaterally with 3 prominent, corneous-tipped spines and 3–4 smaller spines; extensor margin of ischium with single, strong distal spine and 3–4 setae.

Pereopods 4–5 similar; propodus with 3 acute spines, often paired, along distal half of flexor margin; carpus well developed, length subequal to merus, distolateral margin with 10–12 stout spines, ventromedial margin with row of 4–6 spines; merus with about 15 strong spines along distal margin, irregular row of 4–5 corneous spines on flexor margin; ischium with 3–4 corneous spines on distal extensor margin and 6–7 corneous spines on distal flexor margin, ventral margin with 2 clusters of short, corneous spines at approximately ⅓ and ⅔ length of margin.

Pereopods 6–7 similar to pereopods 4–5, but much longer and with more spines.

Penes short, subrectangular.

All pleopods laminar (Fig. 4); bases with reniform lobe on lateral margin; lobes more strongly developed on posterior pleopods.

Pleopod 1 exopod with inner margin rounded, tapering to narrow, rounded distal end; lateral margin straight; plumose setae on entire margin of exopod except proximal half of inner margin. Endopod with lateral and medial margins subparallel, distal end broadly rounded; setae present only on margin of distal third of ramus.

Pleopod 2 endopod and exopod subequal in length, broadly rounded distally. Exopod with plumose setae on entire margin except proximal ⅗ of medial margin. Endopod with row of small, plumose setae on distal half

of medial margin, continuing to midpoint of distal tip of ramus; margin of proximal half of ramus with very fine pubescence. Appendix masculina originating at base of endopod, styliform, unornamented, not extending beyond tip of endopod.

Pleopods 3 and 4 similar. Exopod broadly rounded distally, with very weak indication of suture; plumose setae on distal half of margin. Endopod with lateral margin evenly rounded; medial margin straight proximally, with prominent angle at midpoint of ramus; distal margin sinuous, tapering to narrow tip.

Pleopod 5 endopod and exopod subequal in length. Exopod broadly rounded distally, with very weak indication of suture; plumose setae on entire margin except proximal $\frac{3}{5}$ of medial margin; proximal part of lateral margin ending in posteriorly curved lobe.

Uropod basis with acute posteromedial process extending over half length of endopod, bearing short plumose setae distally, and with dorsal transverse carina ending laterally at junction of rami. Exopod lanceolate, narrow, 3 times longer than wide, approximately $\frac{4}{5}$ length of endopod, tapering distally to subacute tip. Endopod narrow proximally, broadest distally; posterior margin truncate, slightly sinuous, almost straight, reaching posterior margin of pleotelson. Lateral margins of both rami fringed with dense cluster of plumose setae; distal margins and distal half of inner margins of both rami fringed with single row of plumose setae.

Females.—Other than the usual sexual characters, females differ from mature males by lacking the dense setation on lateral margins of both uropodal rami and having 3–5 movable spines distally on the inner margin of the uropodal exopod (Fig. 5G). Females also differ from males by having plumose setae on the exopod of pleopod 1 confined to the distal half of both the medial and lateral margins, whereas on males the setae are confined to the distal half of the medial margin but continue more densely along the entire length of the lateral margin. There is a possibility that spination on the dorsal extensor margin of the ischium of pereopod 1 differs between mature males and females. In males the dorsal surface of that article has setae and no spine, but on most females there is a single strong spine similar to that on the same article of other pereopods. However, one smaller female (35 mm total length) has a pair of setae there and lacks the spine seen on larger females. Finally, medial margins of endopods of pleopods 3 and 4 on females are straight, lacking the prominent angle at midlength evident in males.

Young.—Specimens range in size from 10 to 54 mm total length, and ontogenetic change in some morphological features is great. Manca stages differ from larger specimens in several respects. The median carina on the anterior part of the frontal lamina is obscure in the manca stage but prominent in adults. Pereopod 7 is absent from 40 specimens with total lengths of 10–12 mm and present but not fully developed in 9 specimens with lengths of 14–16 mm; all intact post-manca specimens longer than 17 mm have pereopod 7 fully developed. Relative lengths of pereonal coxae 6 and 7 change with increasing size of the specimens. In specimens shorter than 14 mm, the coxa of pereopod 6 extends posteriorly far beyond the tip of the coxa of pereopod 7, but in longer specimens the coxa of pereopod 7 extends beyond that of pereopod 6.

Setation of the pleopods and uropods also differs between young and adults. In the young, setae on pleopods are relatively longer than in adults, and the distal tip of the endopod of pleopod 4 has 8–9 fine setae, lacking in adults. Setation of the uropods of juveniles is much less dense than that of adults, and an extremely dense cluster of setae occurs along lateral margins of the uropodal rami in adult males. Function of the

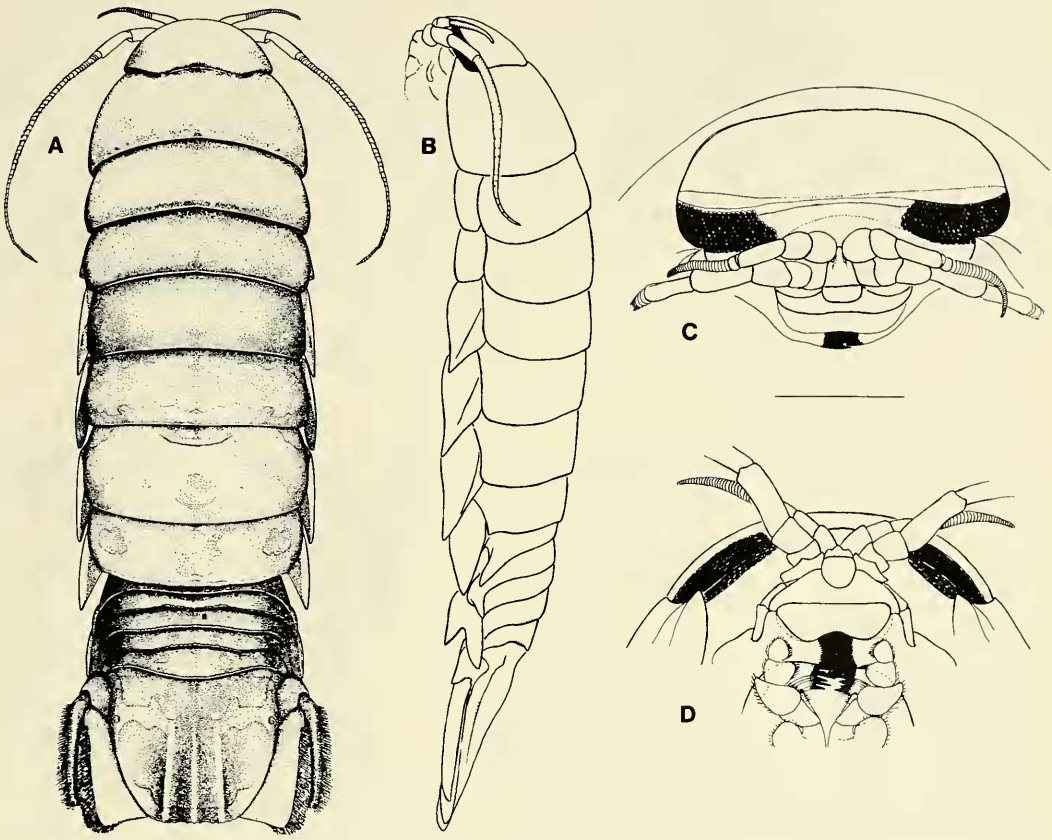

Fig. 1. *Booralana tricarinata,* holotype male: A, Dorsal aspect; B, Lateral aspect (pereopods and pleopods omitted). Adult 42 mm female from Grand Bahama Island: C, Cephalon, onface view; D, Cephalon, ventral view. Scale = 4 mm for C, D.

dense setal cluster in males is unknown, but its presence may indicate sexual maturity. Young males and all females have 3–5 spines on the inner margin of the uropodal exopod, lacking in mature males.

Geographic variation.—There are usually marked differences between males and minor differences between females from the western Bahamas and those from Antillean localities represented by our material. However, the sample size is too small to draw firm conclusions about the significance of differences noted, and there are exceptions in each case. The Bahamian material consists of eight males, three females, and many mancas. The only two intact males from the Antilles and most (12 of 14) of the Antillean females are from a single locality off the north coast of Puerto Rico; the remaining Antillean males are represented only by fragments from fish stomachs.

One difference noted between the two populations is the relative width of the body with respect to its length. Bahamian specimens, for the most part, appear to be relatively narrower than most Antillean specimens, but there are exceptions. The mean body width to length ratio of Bahamian specimens is 1:3.1 $\pm$ 0.252 (n = 9), whereas the mean ratio for Antillean specimens is 1: 2.9 $\pm$ 0.183 (n = 14). The difference is caused by the relatively longer individual pereonal

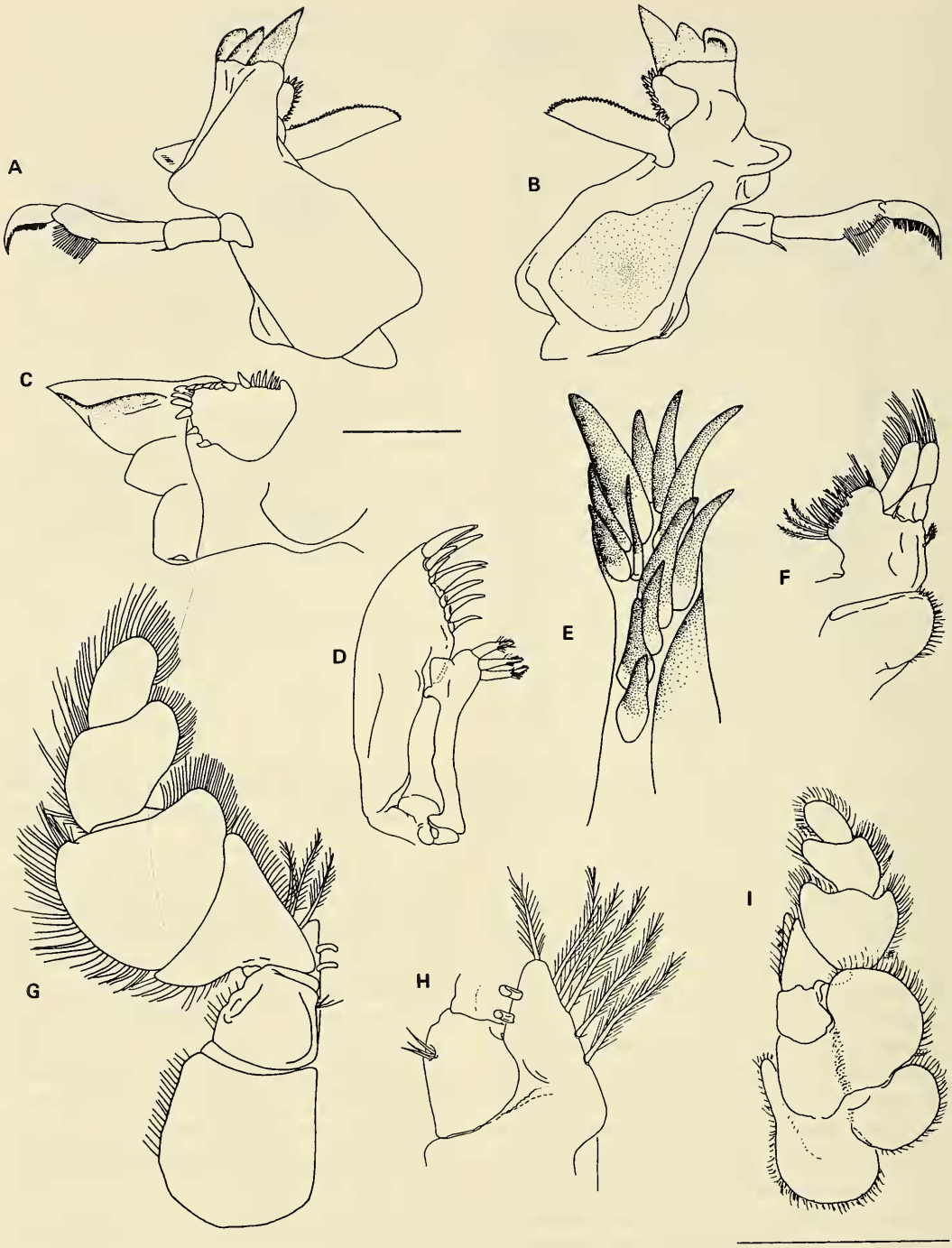

Fig. 2. *Booralana tricarinata,* holotype male: A, Right mandible, ventrolateral aspect; B, Right mandible, dorsomedial aspect; C, Incisor and lacinia mobilis of left mandible, medial aspect; D, Maxilla 1; E, Maxilla 1, onface view of exopodal spines; F, Maxilla 2; G, Maxilliped, ventral aspect; H, Inner plate of maxilliped, dorsomedial aspect. Adult 42 mm female from Grand Bahama Island: I, Left maxilliped. Upper scale = 1 mm for A, B, D, F, G; 0.5 mm for C, E, H. Lower scale = 2 mm for I.

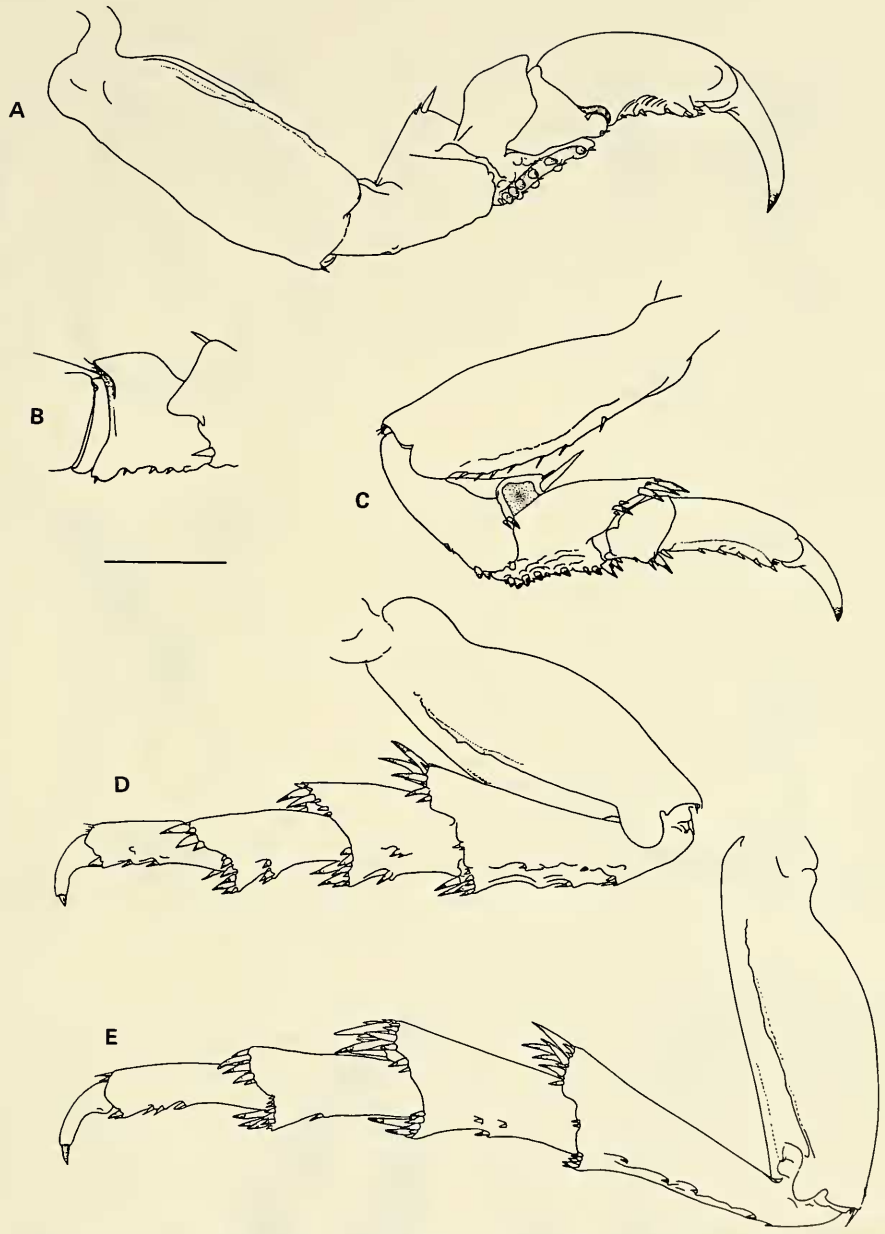

Fig. 3. *Booralana tricarinata,* holotype male: A, Pereopod 1, lateral aspect; B, Pereopod 1, medial aspect, ventral and distal spination of merus and ischium, respectively; C–E, Pereopods 2, 5, and 7, lateral aspects. Scale = 1 mm.

somites of Bahamian specimens when compared to those of Antillean specimens of the same width. Ranges of the overall width to length ratios of the two populations overlap, however. The range for Bahamian specimens is 1:2.8 to 1:3.3, and the range for Antillean specimens is 1:2.6 to 1:3.2.

Another difference involves dentition and setation of the endopod of the uropod (compare Fig. 1B and Fig. 5A–F). In mature Ba-

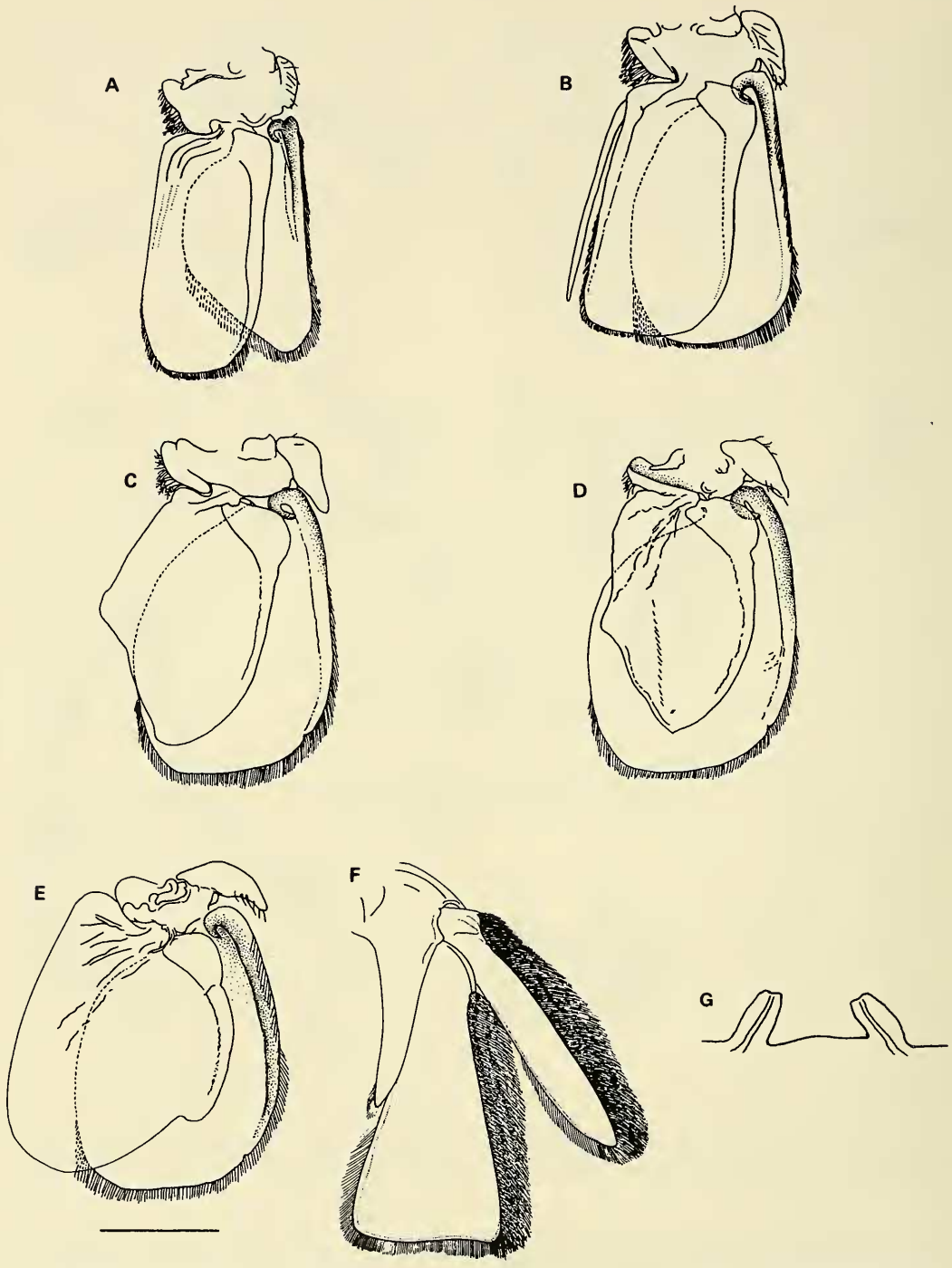

Fig. 4. *Booralana tricarinata,* holotype male: A–E, Pleopods 1–5; F, Right uropod; G, Penes. Scale = 1 mm for A–F, 3 mm for G.

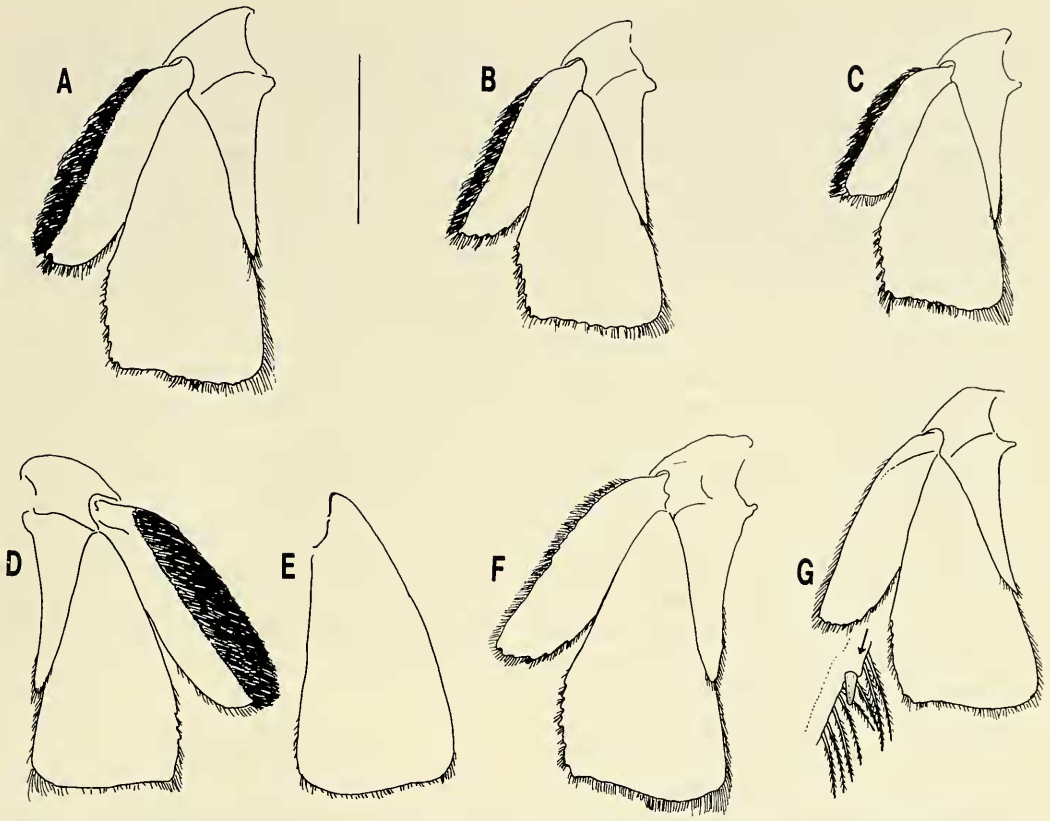

Fig. 5. *Booralana tricarinata:* A–C, Left uropods of 47, 41, and 37 mm males, respectively, from Puerto Rico; D, Right uropod, adult (?) male from British Virgin Islands (fish stomach); E, Endopod, right uropod, adult (?) male from Puerto Rico (fish stomach); F, Left uropod, adult 47 mm female from Puerto Rico; G, Left uropod, adult 42 mm female from Grand Bahama Island. Scale = 2 mm.

hamian males, including the holotype, the distolateral margin of the endopod is entire and has a dense fringe of setae; whereas Antillean males have several sharp tubercles along the distolateral margin and a thin fringe of setae, similar to the condition seen on females from both areas and on smaller subadult males from the Bahamas. Moreover, the tubercles on the distolateral margin are more strongly developed on females from Puerto Rico than on females of similar size from the Bahamas.

The appendix masculina on Bahamian males is relatively shorter than that of males from the Antilles, although there is an exception in this case, too. The appendix masculina on each Bahamian male does not reach the distal end of the inner ramus of the second pleopod, whereas it does reach the distal end of the ramus on each of the two intact males from off the north coast of Puerto Rico and on two of the three fragmented males from elsewhere in the Antilles. However, on one of the fragmented males from Anegada, British Virgin Islands, the appendix masculina is short, not reaching the end of the ramus.

The populations from the Bahamas and the Antillean Islands may be diverging, or the species may be quite variable. We may be seeing in our limited material phenotypic effects of great water depth or temperature differences between the localities represented. Nevertheless, the absence of a dense se-

tal fringe on the endopods of uropods of apparently adult males from the Antilles is worrisome. For now, we have chosen to conservatively consider the populations as one variable species. When more material becomes available, a further investigation can be made of their differences.

Affinities.—*Booralana tricarinata* can be distinguished immediately from *B. bathynella* and *B. wundurra* by the presence and configuration of carinae on the dorsal surface of the pleotelson. *Booralana tricarinata* has one longitudinal carina on the midline of the pleotelson and a pair of submedian carinae. *Booralana bathynella* lacks carinae on the pleotelson; *B. wundurra* has a pair of submedial carinae but lacks one on the midline. The shape of the pleotelson of *B. tricarinata* is most similar to that of *B. bathynella*; in both species the lateral margins of the pleotelson are convex, sloping evenly to a broad, truncate posterior margin. In *B. wundurra* the posterior margin is relatively much narrower than in the other two species, and it is upturned in males. Finally, the eyes of preserved specimens of *B. tricarinata* are brown or black, but the eyes of *B. wundurra* are red (Bruce 1986:136).

The posterolateral notch in the enlarged lateral margin of the third pleonite may be a reliable generic character, although the notch is more weakly developed in *B. wundurra* than in the other two species (N. Bruce, pers. comm.). In specimens of *B. tricarinata* the basal segment of the uropod becomes inserted in the notch when the pleotelson is flexed ventrally. Functionally, this meshing of the pleotelson and pleonite appears to be a locking mechanism used for leverage when the isopod is clinging to a fish carcass.

Etymology.—The specific name, *tricarinata,* refers to the three prominent carinae on the dorsal surface of the pleotelson.

Type locality.—Atlantic Ocean, Northwest Providence Channel, about 3 km southeast of Lucaya, Grand Bahama Island (approximately 26°32′N, 78°33′W), 200–250 m depth.

Distribution and ecology.—*Booralana tricarinata* is known from outer-shelf and upper-slope depths off the Little Bahama Bank and the Antilles Islands; 110–610 m depths.

There was no depth recorded with the sample from Smithsonian-Bredin Station 74-A-58 at Redonda Island, but the female was taken at the anchorage there. The collection data includes the entry "(dip net?)." We have found that the collection was made in depths shallower than those at the collection sites of other material examined, at the surface, with light and dip net.

The limited data indicate that *B. tricarinata* is an epibenthic scavenger, because most of the specimens came from baited mollusk or fish traps. Another isopod captured with *B. tricarinata* in baited mollusk traps off Grand Bahama Island is *Cirolana minuta* Hansen, 1890 (see Kensley & Schotte 1987:233–236).

Acknowledgments

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